LATE WISCONSIN VEGETATION OF ROBBER'S ROOST IN THE WESTERN MOJAVE DESERT, CALIFORNIA

NIALL MCCARTEN
Department of Biology, San Francisco State University,
1600 Holloway Ave., San Francisco, CA 94132

THOMAS R. VAN DEVENDER
Arizona-Sonora Desert Museum, 2021 N. Kinney Rd.,
Tucson, AZ 85743

ABSTRACT

A total of 22 plant taxa were identified from three packrat (*Neotoma* sp.) midden assemblages radiocarbon dated at 12,870–13,330 yr B.P. at 1215 m elevation in Robber's Roost in the Scodie Mountains of Kern Co., California. The Late Wisconsin vegetation was a pinyon-juniper woodland dominated by *Pinus monophylla, Juniperus californica,* and *Ceanothus greggii.* Excellent modern analogs are in Cushenberry Canyon and similar areas on the desert slopes of the San Bernardino and San Gabriel mountains. These woodlands are probably relicts of a pinyon-juniper-Joshua tree woodland that was widespread across the southern Mojave Desert in the Late Wisconsin.

Plant macrofossils from ancient packrat (*Neotoma* sp.) middens have provided a detailed record of the invasion of the present deserts of North America by woodland or forest trees (Van Devender and Spaulding 1979). Woodlands dominated by *Pinus monophylla, Juniperus osteosperma,* and *Yucca brevifolia* were present in many parts of the present Mojave Desert in southern Nevada (Wells and Berger 1967, Leskinen 1975, Spaulding 1981) and southeastern California (Mehringer 1965, Wells and Berger 1967, King 1976, Wells and Woodcock 1985). Characteristic dominants of the modern Mojave desertscrub such as *Larrea divaricata* and *Ambrosia dumosa* were noticeably absent from these areas. In this paper, we present the first analyses of Late Wisconsin packrat midden plant assemblages from the base of the Sierra Nevada on the western edge of the Mojave Desert and discuss their local and regional implications.

STUDY AREA

The Scodie Mountains are on the southeastern end of the Sierra Nevada in Kern Co., California (Fig. 1). They range from 1160 m elevation on the southeastern base to 2075 m on Pinyon Peak and 2170 m on Skinner Peak. The upper portion of the range is in Sequoia National Forest. Walker Pass at 1905 m in Freeman Canyon marks the northeastern edge of the range. The Scodie Mountains divide

MADROÑO, Vol. 35, No. 3, pp. 226–237, 1988

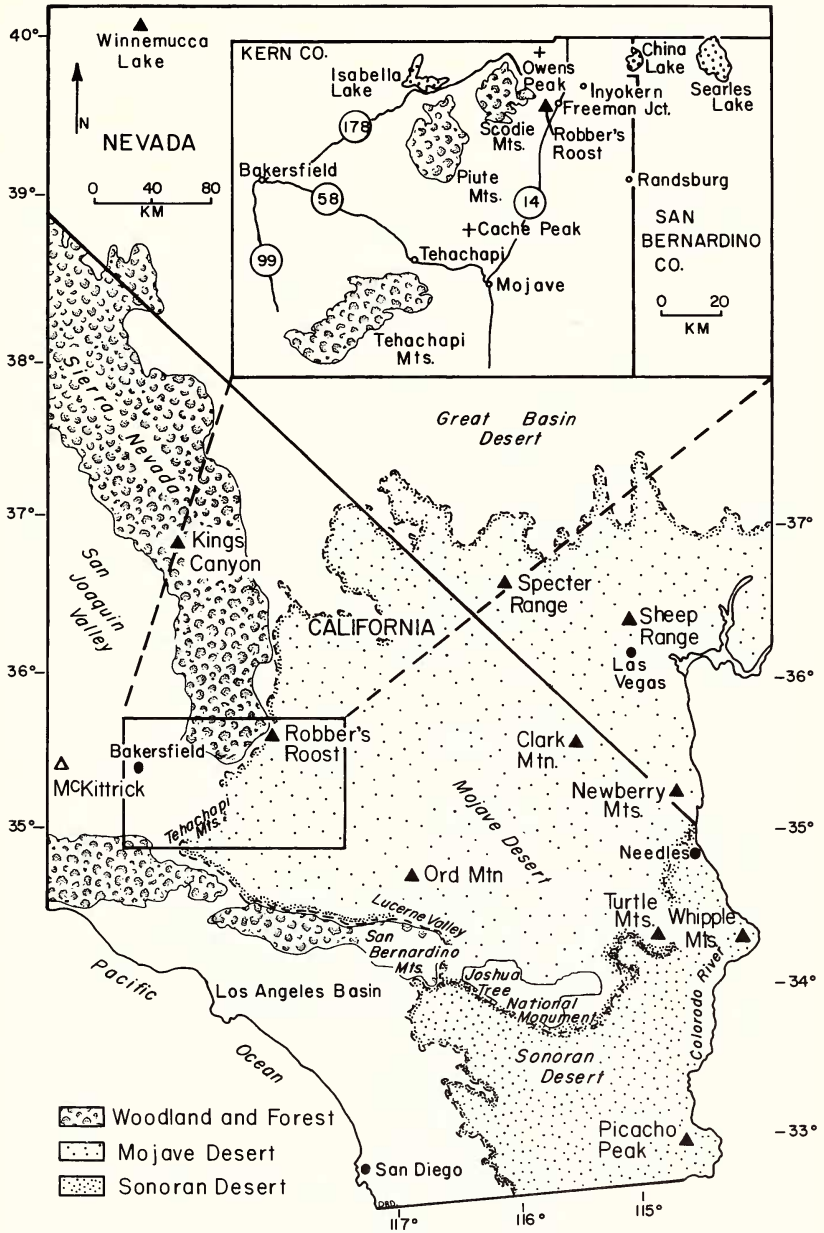

FIG. 1. Map of southern California showing the location of Robber's Roost in the Mojave Desert and in relation to the Sierra Nevada and other fossil packrat midden (solid triangles) and tar pit (open triangle) sites discussed in text. Mojave and Sonoran deserts stippled after Brown and Lowe (1978) and Küchler (1977).

the internal drainage basins of the western Mojave Desert from the Kern River drainage and the San Joaquin Valley. Robber's Roost is a series of rhyolitic plugs at 1190–1230 m elevation on the southeastern edge of the Scodie Mountains (35°35′45″N, 117°57′W), 4.3 km ene. of Freeman Junction. The packrat midden rockshelters are at ca. 1215 m.

The rainshadows of the Scodie Mountains, the Sierra Nevada, and the Transverse Ranges to the south are responsible for the general aridity of the interior Mojave and Great Basin deserts. The climatological means for Inyokern at 590 m, 14 km ne. of Robber's Roost, are 5.8°C for January, 29.2°C for July, and 106 mm/yr precipitation with 7.5% in the summer (June–August; NOAA 1986). Estimates of lapse rates for these climatic variables vary considerably. Major (1977) reported temperature lapse rates of −0.45°C/100 m for January means and −0.60°C/100 m for July means for Owens Valley north of Inyokern. Rowlands (1978) estimated −0.5°C to −0.6°C/100 m for January means in the northern Mojave Desert in general. A lapse rate of 9.4 mm/100 for annual precipitation was found for the western Mojave Desert in general (Rowlands 1978), for Death Valley from 1220 to 1830 m, and for the Kern River Canyon in the southwestern Sierra Nevada (Major 1977). Using these lapse rates the estimated climatic means for Robber's Roost at 1215 m are 2.5°C for January, 25.3°C for July, and 168 mm/yr precipitation with ca. 8% in the summer. If these lapse rates apply to the gradient above Robber's Roost, Skinner Peak at 2170 m would have −2.1°C January mean, 19.7°C July mean, and 255 mm/yr precipitation.

Three vegetation zones occur from 1000 to 2100 m on the east slope of the Scodie Mountains above Robber's Roost (Fig. 2, Table 1). Above 1900 m, all slopes support a mixed woodland of *Pinus monophylla, P. sabiniana, Quercus chrysolepis,* and occasional *Yucca brevifolia.* Important shrubs include *Artemisia tridentata, Eriogonum fasciculatum,* and *Purshia glandulosa.* An open woodland dominated by *Pinus monophylla* and *P. sabiniana* extends down to 1700 m on north slopes in Cow Heaven Canyon.

A mixed desertscrub with low shrubs grows from 1600 to 1900 m on hot, rocky east-facing slopes. Between 1300 and 1600 m a sparse desertscrub includes low shrubs of *Ericameria cooperi, E. cuneata, Purshia glandulosa,* and *Eriastrum densifolium* subsp. *mohavense.* On alluvial fans at these elevations a *Yucca brevifolia* desertscrub community with associated bunchgrasses (e.g., *Elymus elymoides, Oryzopsis hymenoides,* and *Stipa speciosa*) and shrubs (e.g., *Ephedra californica, Ericameria arborescens, Hymenoclea salsola,* and *Salvia dorrii*) is well developed.

Below 1300 m is a desertscrub dominated by *Larrea divaricata* and *Ambrosia dumosa* associated with other desert shrubs and bunchgrasses (Table 1). The Robber's Roost packrat midden site at

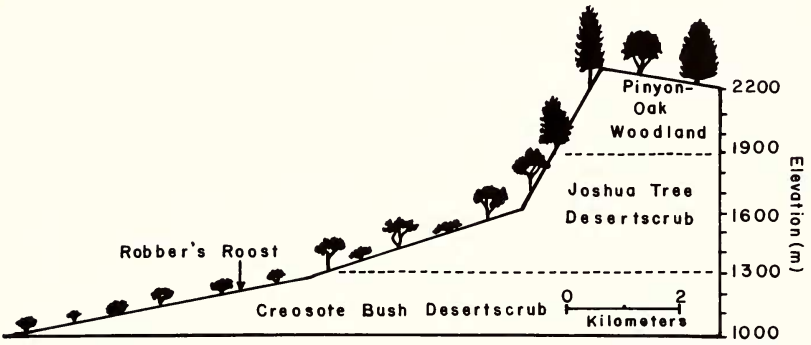

FIG. 2. Generalized vegetation zonation along an east-west transect above Robber's Roost (1215 m elev.) in the Scodie Mountains, Kern Co., California. Scale approximate.

1215 m is in this community (Fig. 3). *Ceratoides lanata, Encelia virginensis, Hymenoclea salsola, Salazaria mexicana,* and *Sphaeralcea ambigua* are scattered in the area. *Chrysothamnus nauseosus, Ericameria arborescens,* and *Ephedra californica* are restricted to relatively mesic microhabitats in the rhyolitic outcrops and along shallow washes. A small (ca. 1 m) plant of *Yucca brevifolia* was found at the edge of a small wash within 50 m of the midden rockshelter.

METHODS AND RESULTS

Packrat middens are hard, dark organic deposits that can be preserved in dry rockshelters for thousands of years. Middens are readily disaggregated by soaking in water, screened through soil sieves, oven dried, and hand sorted. The plant remains provide excellent samples of the local floras on rocky slopes and are excellent for radiocarbon dating. They contain well preserved plant remains collected within ca. 30 m that can often be identified to species.

Three packrat midden samples from Robber's Roost yielded a total of 22 plant taxa with 9–21 per sample. The specimens were identified by comparison with reference collections in the Laboratory for Paleoenvironmental Studies at the University of Arizona (Table 2). This number of taxa is adequate to describe the Late Wisconsin plant community at the site considering that 14–22 species were observed in modern Scodie Mountains communities (Table 1). Relative abundance classes in the fossil assemblages and modern communities were assigned from the most common (abundant = 5) to single specimens (rare = 1). Ranks of the intermediate classes (very common to uncommon, 4–2) varied depending on the total number of specimens identified. Plant nomenclature mostly follows Munz (1974); authorities for exceptions are included in Tables 1 and 2.

TABLE 1. PLANTS OBSERVED IN THE SCODIE MOUNTAINS, KERN CO., AND CUSHENBERRY CANYON, SAN BERNARDINO CO., CALIFORNIA. Authorities cited for names differing from Munz (1974). Relative abundance: 1 = rare, 2 = uncommon, 3 = common, 4 = very common, 5 = abundant. * = identified in Robber's Roost packrat middens.

Species	Scodie Mountains			Cushenberry Canyon (1585–1830 m)
	<1300 m	1300–1600 m	>1600 m	
Ambrosia dumosa	4	—	—	—
**Artemisia tridentata*	—	—	3	5
Atriplex canescens	—	—	—	1
**Ceanothus greggii*	—	—	3	2
Ceratoides lanata (Pursh) J. T. Howell	5	—	—	—
Chrysothamnus nauseosus	—	—	—	2
Echinocereus engelmannii	—	—	—	2
Elymus elymoides (Raf.) Swezey	1	4	—	—
Encelia virginensis	3	2	—	1
Ephedra californica	1	4	3	—
Ephedra viridis	—	—	—	3
Ericameria cooperi (A. Gray) Hall	—	1	—	2
**Ericameria cuneata* (A. Gray) McClat.	—	2	—	—
Ericameria laricifolia (DC.) Urbatsch & Wussow	2	2	—	2
Ericameria linearifolia (T. & G.) Urbatsch & Wussow	—	—	—	2
Eriodictyon crassifolium	—	—	—	2
**Eriogonum fasciculatum*	3	4	1	2
Fremontodendron californicum	—	—	—	2
Gutierrezia microcephala	—	—	—	2
Hymenoclea salsola	4	3	1	—
**Juniperus californica*	—	—	2	—
Juniperus osteosperma	—	—	—	3
Larrea divaricata Cov.	3	—	—	—
**Lepidium fremontii*	3	2	—	2
**Lupinus excubitus*	—	3	—	—
Lycium andersonii	—	2	—	2
Machaeranthera tortifolia	2	3	—	—
Mirabilis bigelovii	4	3	—	2
**Opuntia basilaris*	2	3	2	2
**Opuntia echinocarpa*	3	2	—	2
Opuntia phaeacantha	—	—	—	2
Oryzopsis hymenoides	1	4	—	—
**Penstemon incertus*	—	3	—	—
**Pinus monophylla*	—	—	5	5
Pinus sabiniana	—	—	5	—
Poa secunda Presl.	—	—	—	2
Prunus andersonii	—	—	2	—
Prunus fasciculata	—	—	—	1
**Purshia glandulosa*	—	—	3	2

TABLE 1. CONTINUED.

Species	Scodie Mountains <1300 m	Scodie Mountains 1300–1600 m	Scodie Mountains >1600 m	Cushenberry Canyon (1585–1830 m)
Quercus chrysolepis	—	—	4	—
**Quercus turbinella*	—	—	—	2
Salazaria mexicana	3	3	—	2
Salvia dorrii	—	—	3	1
Sphaeralcea sp.	4	1	—	1
Stipa speciosa	3	5	—	2
Tetradymia spinosa	—	3	—	—
**Yucca brevifolia*	1	4	1	3
Total =	19	22	14	31

Radiocarbon dates on twigs and seeds of *Juniperus californica* from the samples yielded ages of 12,870 ± 400 (A-1762, RR#1D), 12,960 ± 270 (A-1761, RR#2A), and 13,330 ± 360 (A-1763, RR#1C) yr B.P. (radiocarbon years before 1950). Attempts were not made

FIG. 3. View of packrat midden site at Robber's Roost, Kern Co., California. A pinyon-juniper woodland grew in the area from 12,870 to 13,330 yr B.P. in the Late Wisconsin.

to expand the three Late Wisconsin samples into a local chronology because of the rarity of fossil middens in the area.

Although the *Neotoma* teeth from the samples were not identifiable to species, they had rounded lophs characteristic of *N. albigula, N. fuscipes,* and *N. lepida* rather than the prismatic teeth of *N. cinerea* or *N. mexicana. Neotoma albigula* inhabits various communities in summer rainfall areas from southeasternmost California east to central Texas and the Mexican Plateau; it was probably not the builder of the Robber's Roost middens. More likely candidates are *N. lepida* of the Mojave Desert and nearby woodlands, or *N. fuscipes* of Sierran and coastal chaparral.

Discussion and Conclusions

The plant assemblages from the Robber's Roost packrat middens record a Late Wisconsin pinyon-juniper woodland dominated by *Juniperus californica* and *Pinus monophylla* in association with *Ceanothus greggii, Purshia glandulosa, Artemisia tridentata, Eriogonum fasciculatum, Yucca brevifolia, Quercus turbinella,* and *Ericameria cuneata* (Table 2). Twelve species (54.5%) identified from the samples no longer occur in the Robber's Roost area. Preliminary electrophoretic studies of phenolics including flavonoids suggest that the fossil junipers represent *J. californica* rather than *J. osteosperma.* The modern woodland above 1900 m is not a good analog of the Robber's Roost paleowoodland because *J. californica, C. greggii,* and *Q. turbinella* are rare or absent and *P. sabiniana* and *Q. chrysolepis* are associated with *P. monophylla.* The nearest populations of *J. californica* and *C. greggii* are 9 km nw. of Robber's Roost in Walker Pass at 1750 m elevation. Farther west, the vegetation begins a gradual transition to chaparral in South Fork Valley north of the Piute Mountains. The nearest populations of *Quercus turbinella* are in Kern Co. at Erskine Canyon in the northwestern Piute Mountains (ca. 40 km w.) and in the northeastern Tehachapi Mountains (47 km ssw.; Twisselman 1967; Fig. 1).

Estimates of climatic parameters for Robber's Roost in the Late Wisconsin using lapse rates discussed above for a 685 m minimum lowering of *Pinus monophylla* in the Scodie Mountains are −0.75°C mean for January, 21.3°C for July, and 218 mm/yr precipitation with little in summer. As mentioned above the Scodie Mountains woodland is a poor analog, suggesting the modern climates may also be different. Different lapse rates in the Late Wisconsin would yield different estimates. The paleoclimatic estimates are within the climatic limits estimated for modern pinyon-juniper woodlands in the mountains of the eastern Mojave Desert by Thorne et al. (1981): e.g., January mean less than 4°C, July mean less than 25.5°C, and annual precipitation greater than 250 mm/yr with 165–185 mm in

TABLE 2. PLANT MACROFOSSILS IDENTIFIED FROM PACKRAT MIDDENS FROM ROBBER'S ROOST, SCODIE MOUNTAINS, KERN CO., CALIFORNIA. Authorities cited for names differing from Munz (1974). Relative abundance: 1 = rare, 2 = uncommon, 3 = common, 4 = very common, 5 = abundant. Distribution: n = presently occurs in Robber's Roost; e = extralocal, no longer lives in area; ka = thousands of years ago.

Species	Material	RR#1D (12.9 ka)	RR#2A (13.0 ka)	RR#1C (13.3 ka)
Ambrosia sp.	burs	—	1n	1n
Amsinckia tessellata	nutlets	—	1n	—
Artemisia tridentata	leaves, wood	—	2e	3e
Ceanothus greggii	leaves	2e	3e	4e
Chrysothamnus sp.	achenes, involucres	—	1n	1n
Encelia sp.	achenes	—	1n	—
Ephedra sp.	stems	—	1n	—
Eriastrum sp.	leaves	—	1e	—
Ericameria arborescens Greene	involucres, leaves	1n	1n	1n
Ericameria cuneata (A. Gray) McClat.	leaves	—	2e	—
Eriogonum fasciculatum	inflorescence, leaves, stem	—	1n	1n
Juniperus californica	seeds, stems	5e	5e	5e
Lepidium fremontii	capsules	—	1n	1n
Lupinus excubitus	leaves	2e	2e	3e
Lycium sp.	leaves	2e	2e	2e
Opuntia basilaris	seeds	—	2n	—
Opuntia echinocarpa	spines	2n	2n	2n
Penstemon incertus	seeds, fruit, leaves, stems	—	—	2e
Pinus monophylla	seeds, cone scales, leaves	3e	2e	2e
Purshia glandulosa	fruit, leaves	1e	3e	3e
Quercus turbinella	leaves	—	1e	—
Yucca brevifolia	leaves	2e	2e	—
Total = 22		9	21	14

the cool seasons (September to May). This would represent an increase in annual and winter precipitation at Robber's Roost of about 36%.

An excellent modern analog to the Robber's Roost paleocommunity is on the north slopes of the San Bernardino Mountains above the Lucerne Valley (Fig. 1) in San Bernardino Co. An extensive pinyon-juniper woodland in Cushenberry Canyon (1830 m) is dominated by *Pinus monophylla, Juniperus osteosperma,* and *Yucca brevifolia* and also includes *Atriplex canescens, Artemisia tridentata, Ceanothus greggii, Chrysothamnus nauseosus, Ephedra viridis, Ericameria linearifolia, Eriogonum fasciculatum, Opuntia basilaris, O. echinocarpa, O. phaeacantha, Purshia glandulosa, Quercus turbinella,* and *Salvia dorrii. Encelia virginensis* and *Lepidium fremontii* were seen just below at 1585 m. *Juniperus californica* is present in the lower portion of the woodland. This area is 500–700 m higher than Robber's Roost and 170 km to the southeast. Similar woodlands can be found in other areas along the desert slopes of the San Bernardino and San Gabriel mountains.

The Robber's Roost paleowoodland is also similar to modern woodlands isolated in the mountains of the eastern Mojave Desert (Thorne et al. 1981). Late Wisconsin pinyon-juniper woodlands with *Pinus monophylla* have been recorded in the Mojave Desert from Ord Mountain (King 1976), the Turtle Mountains (Wells and Berger 1967), and Clark Mountain (Mehringer and Ferguson 1969) in California and the Newberry Mountains (Leskinen 1975), Spring Range (Van Devender and Spaulding 1979), Sheep Range (Spaulding 1981), and Specter Range (Spaulding 1985) in Nevada. Xeric woodland assemblages dominated by *Juniperus californica* with low levels of *Pinus monophylla, Yucca brevifolia,* and *Y. whipplei* have been found as low as 510 m in the Whipple Mountains just above the Colorado River in eastern San Bernardino Co. (Van Devender and Spaulding 1979, Van Devender et al. 1987). These relict distributions of modern woodlands and their fossil records suggest that pinyon-juniper woodland was widespread across the central and southern Mojave Desert in the Late Wisconsin (Wells 1986, Betancourt 1986).

Full-glacial packrat midden records from King's Canyon in the Sierra Nevada (170 km nnw. of Robber's Roost) record the expansion of *Pinus monophylla* even farther to the west (Cole 1983). Fossils of *P. monophylla* and *J. californica* (including *J. osteosperma*) were reported from the Late Pleistocene McKittrick asphalt deposits at 320 m elevation in the San Joaquin Valley 170 km wsw. of Robber's Roost (Mason 1944). The plant fossils were associated with extinct mammals characteristic of the Rancholabrean Land Mammal Age including *Bison, Camelops, Equus, Hemiauchenia, Mammut,* and *Mammuthus* (Harris 1985). A middle Wisconsin radiocarbon age (38,000 ± 2500 yr B.P.) was obtained on plant materials

from the site (Kurtén and Anderson 1980). These records suggest that many of the disjunct populations of Great Basin plants did not disperse into the Sierra Nevada during the "warm, dry Xerothermic" dispersal (=middle Holocene; Taylor 1976, Axelrod 1981) but in glacial climates in the Wisconsin if not earlier.

The Robber's Roost paleoflora is especially interesting because of its location near the eastern base of the Sierra Nevada. A number of trees that potentially could have dispersed southward along the main axis or eastward from the mesic west slopes of the Sierra or northwest from the Transverse Ranges were not found; e.g., *Abies concolor, A. magnifica, Calocedrus decurrens, Juniperus occidentalis, Pinus coulteri, P. lambertiana, P. jeffreyi, P. ponderosa, Pseudotsuga macrocarpa, Quercus agrifolia, Q. douglasii, Q. lobata,* or *Sequoiadendron giganteum.* Thompson et al. (1985) reported an eastward expansion of *J. occidentalis* from the Sierra Nevada into the Winnemuca Lake Basin of Nevada in the Great Basin. Plants indicative of the *Adenostoma fasciculatum*-dominated chaparral of the Los Angeles Basin have not been found in middens.

Packrat middens from the Mojave and Sonoran deserts have yielded records of some plants now found in the chaparral and woodlands of the interior slopes of the mountains of southern California with more extensive eastern distributions in the Late Wisconsin and early Holocene. Most of them presently have disjunct populations in woodland, chaparral, or desertscrub communities in Arizona or Sonora (e.g., *Arctostaphylos pungens, Ceanothus greggii, Eriogonum fasciculatum, Juniperus californica, Nolina bigelovii, Quercus chrysolepis, Q. dunnii, Q. turbinella, Yucca brevifolia,* and *Y. whipplei*). Most Late Wisconsin dispersals of woodland, chaparral, or desertscrub species into the Mojave Desert recorded by packrat midden fossils were from the north or northeast.

Plant remains in packrat middens from Robber's Roost and other areas in the Mojave Desert provide insight into the historical components in modern communities. The modern vegetation of Robber's Roost is a mixture of species that were present in the Late Wisconsin woodland and warm desert species that dispersed into the area in the Holocene. The regional vegetation of the western Mojave Desert reflects similar historical processes with pinyon-juniper woodlands contracted to isolated mountaintops or the lower elevational zones of larger mountain ranges. In the Late Wisconsin a Mojave desertscrub with *Larrea divaricata* and *Yucca brevifolia* was present below 310 m in the Picacho Peak area in Imperial Co., California (Van Devender et al. 1985, Cole 1986). The area is just north of Yuma in the modern Lower Colorado River Valley subdivision of the Sonoran Desert. The *Larrea divaricata–Ambrosia dumosa* desertscrub of much of the Mojave Desert developed in the last 11,000 years as these species and their associates migrated from

their glacial refugium in the Lower Colorado River Valley and the Gran Desierto surrounding the head of the Gulf of California in Sonora and Baja California. Great Basin elements of the paleowoodlands survive today in the region as elevational zones dominated by *Artemisia tridentata* and in mixed desertscrub communities in the western Mojave Desert (e.g., *Artemisia spinescens, Atriplex confertifolia,* and *Ceratoides lanata*).

Acknowledgments

We thank Austin Long for the radiocarbon dates, Don Koehler for identification of the *Purshia glandulosa* fossils, Ron Lanner for anatomical analysis of the fossil *Pinus monophylla* needles, and Roxanne Bittman, Jim Yates, Alan Davis, Andy Sanders, and Dave Morafka for their help in the field. The careful editing of Wayne R. Ferren, David J. Keil, and two anonymous reviewers greatly improved the paper. This research was supported in part by National Science Foundation grant DEB 75-13944 to Paul S. Martin. Dana Dorner and Helen Wilson drafted the diagrams. Jean Morgan typed the manuscript.

Literature Cited

Axelrod, D. I. 1981. Holocene climatic changes in relation to vegetation disjunction and speciation. American Nat. 117:847–870.

Betancourt, J. L. 1986. Paleoecology of pinyon-juniper woodlands: summary. *In* R. L. Everett, compiler, Proceedings—pinyon-juniper conference, p. 129–139. Intermountain Res. Station, U.S.D.A. Forest Serv., Ogden, UT.

Brown, D. E. and C. H. Lowe. 1978. Biotic communities of the Southwest. U.S.D.A. Forest Serv. Gen. Tech. Rept. RM-41. Rocky Mountain Forest and Range Exp. Sta., Fort Collins, CO.

Cole, K. L. 1983. Late Pleistocene vegetation of King's Canyon, Sierra Nevada, California. Quarternary Res. 19:117–129.

———. 1986. The Lower Colorado Valley: a Pleistocene desert. Quarternary Res. 25:392–400.

Harris, A. H. 1985. Late Pleistocene vertebrate paleoecology of the West. Univ. Texas Press, Austin.

King, T. J. 1976. Late Pleistocene–Early Holocene history of coniferous woodlands in the Lucerne Valley region, Mohave Desert, California. Great Basin Naturalist, 36:227–238.

Küchler, A. W. 1977. Natural vegetation of California. *In* M. G. Barbour and J. Major, eds., Terrestrial vegetation of California, map. John Wiley and Sons, New York.

Kurtén, B. and E. Anderson. 1980. Pleistocene mammals of North America. Columbia Univ. Press, New York.

Leskinen, P. H. 1975. Occurrence of oaks in late Pleistocene vegetation in the Mohave Desert of Nevada. Madroño 23:234–235.

Major, J. 1977. California climate in relation to vegetation. *In* M. G. Barbour and J. Major, eds., Terrestrial vegetation of California, p. 11–74. John Wiley and Sons, New York.

Mason, H. L. 1944. A Pleistocene flora from the McKittrick asphalt deposits of California. Proc. Calif. Acad. Sci. 25:221–233.

Mehringer, P. J. 1965. Late Pleistocene vegetation in the Mohave Desert of southern Nevada. J. Arizona Acad. Sci. 3:172–188.

——— and C. W. Ferguson. 1969. Pluvial occurrence of bristlecone pine, *Pinus aristata,* in a Mohave Desert mountain range. J. Arizona Acad. Sci. 5:284–292.

Munz, P. A. 1974. A flora of southern California. Univ. California Press, Berkeley.
National Oceanic and Atmospheric Administration. 1986. Climatological data—California: annual summary. 90:1–57.
Rowlands, P. G. 1978. The vegetation dynamics of the Joshua tree (*Yucca brevifolia* Engelm.) in the southwestern United States of America. Ph.D. dissertation, Univ. California, Riverside.
Spaulding, W. G. 1981. The late Quarternary vegetation of a southern Nevada mountain range. Ph.D. dissertation, Univ. Arizona, Tucson.
———. 1985. Vegetation and climates of the last 45,000 years of the vicinity of the Nevada Test Site, south-central Nevada. U.S. Geol. Survey Prof. Pap. 1329: 1–83.
Taylor, D. M. 1976. Disjunction of Great Basin plants in the northern Sierra Nevada. Madroño 23:301–364.
Thompson, R. S., L. Benson, and E. M. Hattori. 1985. A revised chronology for the Last Pleistocene lake cycle in the central Lahontan Basin. Quarternary Res. 25:1–9.
Thorne, R. F., B. A. Prigge, and J. Henrickson. 1981. A flora of the higher range and the Kelso Dunes of the eastern Mojave Desert in California. Aliso 10:71–186.
Twisselman, E. C. 1967. A flora of Kern County, California. Univ. San Francisco, San Francisco, CA.
Van Devender, T. R., P. S. Martin, R. S. Thompson, K. L. Cole, A. J. T. Jull, A. Long, L. J. Toolin, and D. J. Donahue. 1985. Fossil packrat middens and the tandem accelerator mass spectrometer. Nature 317:610–613.
——— and W. G. Spaulding. 1979. Development of vegetation and climate in the southwestern United States. Science 204:701–710.
———, R. S. Thompson, and J. L. Betancourt. 1987. Vegetation history of the Southwest: the nature and timing of the Late Wisconsin-Holocene transition. *In* W. F. Ruddiman and H. E. Wright, Jr., eds., North America and adjacent oceans during the last deglaciation, p. 323–352. Geol. Soc. America, Boulder, CO.
Wells, P. V. 1986. Systematics and distribution of pinyons in the late Quarternary. *In* R. L. Everett, compiler, Proceedings—pinyon-juniper conference, p. 104–108. Intermountain Res. Station, U.S.D.A. Forest Serv., Ogden, UT.
——— and R. Berger. 1967. Late Pleistocene history of coniferous woodland in the Mohave Desert. Science 155:1640–1647.
——— and D. Woodcock. 1985. Full-glacial vegetation of Death Valley, California: juniper woodland opening to *Yucca* semidesert. Madroño 32:11–23.

(Received 17 Apr 1987; revision accepted 11 Feb 1988.)

ANNOUNCEMENT

New Publication

Barbour, M. G. and W. D. Billings, eds. 1988. *North American terrestrial vegetation.* Cambridge Univ. Press, New York. 434 pp. ISBN 0-521-26198-8 (clothbound), $49.50. [Vegetation of North America including tropical areas. Thirteen chapters, each separately authored and with its own references. Illustrated with black and white photographs, maps, and diagrams.]